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Abstract

ELECTRICITY SUPPLY AND THE ROLE OF
NUCLEAR POWER IN CANADA

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1. Development, construction and operation of heavy-water-moderated and -cooled natural-uranium power reactors has proceeded successfully along the lines indicated at the 1958 Conference. The latest power cost estimates and details of construction of this CANDU family of reactors are reported in other papers at this Conference. Operating and construction experience, together with these estimates and designs, provide the basis for this paper.
2. It is interesting to compare forecasts of Canadian electricity demand and supply for the period 1955 - 1980 made at previous Conferences with the latest estimates and revised economic data. Installed capacity is above forecasts, and there have been significant developments in hydro-electric, fossil fuel and nuclear generation which have a major effect on the economics of each system.
3. Modern engineering considerations of river systems have increased the potential of individual hydroelectric schemes, and the now possible use of economic long-distance transmission lines has ensured the development of very large blocks of remotely located hydroelectric power for use at load centres at competitive prices, i. e., ~ 4 mills/kWh with provincial government financing.
4. Fossil fuel for thermal generating stations is now cheaper and more readily available across most of Canada than previously. Larger and more efficient steam-raising units will therefore also produce electric power in the 4 mills/kWh range.
5. Our nuclear power reactor development has more than kept pace. Lower costs for fuel and special materials combined with projected economies arising from the construction and operation of very large plants promise electricity production at less than 4 mills/kWh. During the 1970's installation of nuclear generating stations should proceed as previously forecast.

6. About 1980 a very rapid increase in the proportion of nuclear generating to other types of stations being built seems likely for several reasons.
7. Forecasts show increasing demands for electricity and, by this time, the annual increments in every section of the country would be substantial.
8. The harnessing of the major obvious water power resources will be essentially complete, and significant areas are remote from sources of fossil fuel at very low prices.
9. On the other hand, the reduction of materials and operating costs will enable large nuclear stations to generate power more cheaply than originally planned, and new stations will still be falling in cost. Costs of special materials will be lower, and fuel costs should be both low and stable for a considerable period of time after 1980.
10. It will not be possible to make meaningful forecasts of nuclear fuel supplies available at such low prices until a truly commercial demand has been built up and has been operating for at least a few years (i. e., after 1980). Uranium, however, represents only a small component of the total cost of electricity generation in a CANDU system. Moreover, if its cost rises to double the figures predicted for the 1980's, fuel recycle and uranium-thorium convertor reactors will become competitive and stabilize the cost of electricity from these nuclear plants at a level that will not be significantly higher than predicted for the natural-uranium cycle with no reprocessing.



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Abstract

UTILIZATION OF CANADIAN RESEARCH REACTORS

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1. In Canada there are three high-flux reactors: the heavy-water-moderated reactors NRX and NRU at the Chalk River Nuclear Laboratories, and the McMaster Nuclear Reactor at McMaster University.
2. NRX is a 40-MW reactor with a maximum thermal-neutron flux of $10^{14} \text{ cm}^{-2} \text{ s}^{-1}$. The basic fuel was recently changed from uranium metal to uranium dioxide with enrichment spikes. This increased the flux by 40%, extended the fuel lifetime, and provided a large-scale test of UO_2 . The transition was made without interrupting the full utilization of the reactor. Many modifications have been made to the NRX system since the start-up in 1947. The control methods have been modified several times to keep pace with improved technology. The power has been raised and the structure has been altered to accommodate loops. NRU has been in operation since 1957 and is now being converted to a fully enriched reactor for operation at the same flux level as before ($3 \times 10^{14} \text{ cm}^{-2} \text{ s}^{-1}$), but at a power of 60 MW instead of the previous 220 MW.
3. For the development of economic nuclear power, a matter of primary interest in the Canadian program, fuel and material tests are essential. NRX has seven high-pressure, high-temperature loops for such tests with various coolants (water, boiling water, fog, steam, and organic fluid) and one low-pressure low-temperature loop for studying problems of moderator chemistry; in NRU two of the three core positions designed for loops have been used. Fundamental research in physics, chemistry and biology is another major interest, and the intense neutron fluxes have opened new areas of investigation. About twenty-five horizontal holes through the reactor shields are in use for experiments. Radioisotopes, especially ^{60}Co , are produced on a commercial basis as well as for research. Other papers at this Conference describe in more detail the research and development done with these facilities.

4. The wide variety of work at the Chalk River reactors requires many supporting services and facilities, with a well-integrated organization and good liaison between the scientists, engineers and works personnel. Over the years the accumulation of operating experience has resulted in the development of procedures for the efficient use of the reactors. Full use is made of modern computer techniques for scheduling maintenance and other work during shutdown. Many reactor operators from Canada and other countries have been trained on NRX and NRU.
5. The McMaster Nuclear Reactor, a 1-MW pool reactor operated by McMaster University, represents a different scale of operation appropriate to teaching institutions. The installation provides a thermal column, six beam ports and a pneumatic rabbit system. Associated facilities include a hot cell, a gamma irradiation room and a fast-neutron generator. The research, mainly fundamental in nature, is being done by members of the departments of biology, chemistry, chemical engineering, geology, medical research, mechanical engineering, metallurgy and physics. It has proved possible to provide for the university research program with a small operating staff and simple organization.